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The Use of Mathematical Logic in Determining Deliberation Decisions Models

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Abstract: In this era of globalization, human life is always followed by various problems that must be taken with a decision. There is not a day without decision making. There is an opinion that all his behavior is a reflection of the results of the decision-making process through his mind so that humans very often make decisions. Through the problem identification process until the selection is the best solution and this is what is called the decision-making process. The method used in this paper is Mathematical Logic. This method has the concept of determining a statement in which there is a premise which from that premise then through a truth table, a person's statement can be drawn a conclusion. This research was conducted at the time of deliberation, in which standard decision making is used to determine the decision by voting or the majority.

Keywords: Logic; Mathematics; Deliberation

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INTRODUCTION

Logic comes from the noun logos which means mind or reason, and ratio means consideration. So that logic can be interpreted as the science of how we should think to produce reasonable (valid) considerations. Thinking is an activity of the soul to achieve a knowledge. Knowledge is what we know. Knowing is a belief about the existence of a correspondence between ideas and reality or reality. Ideas are the result of thought processing and reality is the result of responses, both responses through the five senses (concrete sensory facts) and responses through reflection (abstract ideal reality).[1]

Logic plays an important role in various scientific fields, ranging from computer science, physics, chemistry, mathematics and so on. Therefore, usually students, teachers, students, and lecturers agree that logic plays an important role in various scientific fields, even in everyday life. As an illustration when we are faced with two choices, of course we will think which of the two choices should we choose? Isn't when we make decisions we also use logic to make those decisions. Deliberation is a community activity to solve problems or issues that are decided by consensus, and of course the science of logic plays a very important role in deliberation activities. Logic can improve the ability to think carefully, abstractly, and objectively as well as add intelligence and also improve the ability to think sharply and independently.

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METHODS

After doing a literature search, there are several studies that have been carried out related to mathematical logic. Based on the search, several research results were obtained that have similarities, namely:

a. Research conducted by (Ristiawan, 2018)[2] with the title improving the ability to apply mathematical logic through a realistic approach at SMAN 19 Bekasi. Rifki concludes that: a) student activity has increased in each cycle, the highest percentage of student activity is in cycle 3, which is 85.26%. Meanwhile, the teacher's activities during the learning process are always based on the planned learning stages. (b) the application ability of students before the realistic learning approach was applied was 31.85% indicating very low criteria. (c) The average logic application ability of students in cycle 1 is 65.42% with sufficient criteria, cycle 2 is 70.6% with sufficient criteria, and cycle 3 is 76.10% with high criteria. (c) students' application abilities after applying the realistic learning approach showed a high criterion of 75.85% and an increase of 44% from students' application abilities before learning. It can be said that learning mathematical logic using a realistic approach can improve students' application abilities even though the increase cannot directly reach the maximum criteria.
b. Research conducted by (Pamboenan, et al, 2014) with the title of applying the numbered heads together type of cooperative learning model to improve student learning outcomes on mathematical logic inference material in class X SMA GPID Palu has the conclusion that there is an increase in student learning outcomes in drawing conclusions material Mathematical logic follows the following phases: (1) the phase of delivering goals and motivating students, (2) the phase of presenting information, (3) the phase of organizing study groups and numbering, (4) the phase of asking questions/problems[3].

The method contains how to solve a problem, for example with sets, graph theory or others. The method used by the author to solve this research problem is described with the following steps:

1. Truth Table
   Problems addressed include:
   Is it true that logic can solve problems in deliberation?
2. Propositional Algebra

Problems addressed include:

Literary Studies

The literature study was carried out using a literature study to understand various theories derived from information sources. Sources of information in this research can be obtained through various library data (encyclopedias, scientific journals, magazines, the Internet, and documents). Literature research is carried out by studying things from research in general, namely finding the advantages and disadvantages of using an informatics logic system, various methods of completion and how to solve informatics logic.

Knowledge Acquisition

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The knowledge acquisition stage is also called the stage of collecting knowledge data about the problem from a deliberation. And the information data is to be studied, processed and organized in a structured manner into a knowledge base.

Knowledge Representation

This stage is the stage used to determine the best opinion from a deliberation. Knowledge representation consists of problem analysis using logical operations, designing and constructing a truth table and analyzing a truth table.

Testing

At this stage, testing is carried out to test a problem by comparing several problems to strengthen the evidence that a problem can be solved in this way.

RESULT AND DISCUSSION

In its application, a deliberation decision can be taken through the science of informatics logic. We take an example, for example there are 2 different opinions that have not been approved and are still being considered. Therefore, it is necessary to determine which opinion should be the best.

By identifying these opinions, we will use a Logical Operation before heading to the truth table.

Problem model:
Statement 1: All reforms in this village must be addressed as soon as possible.
Statement 2: Each renewal is carried out equally.

Reasoning the Proposition based on the premise

A proposition is a statement in the form of a news sentence that has two possible truth values, namely true or false but not at the same time true and false. True or false a proposition or statement is called the truth value of the statement [4]. a sentence is said to be true if the things contained in the statement match or match the actual situation (correspondence theory) or are consistent with previous statements (consistency theory). The first statement is often also called a factual statement.[5]for example: AchmadYani is the commander of the Army; Karate is one of the martial arts.

A narrative is said to be incomplete if it does not include a complete meaning; for example: when I was teaching. Whatever book we read, and whatever our conversation, must consist of sentences. But we all know that all sentences are not the same. There are sentences that are really narratives, there are those that simply express wishes, orders, calls, etc. Logic only questions about the reasoning because it is reasoning (thinking) and reasoning is a mere intellectual process. Propositions can also be defined as expressions or decisions in words, or also manifestations of contributions from a decision.[6]

Deductive reasoning is reasoning based on premises that are assumed to be "true" so that later propositions can be concluded. The characteristics of deductive reasoning are: (1) Analytical, the conclusion is attractive only by analyzing existing propositions or premises. (2) Tautologies, the conclusions drawn are actually implicitly contained in the premises. (3) A priori, Conclusions are drawn without sensory observations or campus operations. (4) Deductive arguments can always be valid or not.[7]

Example :

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1) All new HRD carry out their duties.
2) Boy is the new HRD. Conclusion: Boy does his job.

Inductive reasoning is reasoning based on premises that contain general facts so that conclusions can be drawn.[8].The characteristics of inductive reasoning include:

(1) the premise of inductive reasoning is an empirical proposition that is captured by the senses. (2) The conclusion in induced reasoning is broader than what is stated in the premises. (3) Although the conclusion is not binding, but humans accept it. So the inductive conclusion has rational credibility (probability).[7]

Example :
Premise 1 -> 1st car, Refuel using gasoline.
Premise 2 -> 2nd car, Refuel using gasoline.
Premise 3 -> 3rd car, Refuel using gasoline.
Premise 20 -> 20th car, Refuel using gasoline.
It can be concluded that: All cars refuel with gasoline.

From the problem model above, we use Deductive Reasoning. The form of reasoning that has been made is as follows :

Statement 1: All reforms in this village must be addressed as soon as possible.
Statement 2: Each renewal is carried out equally.
In conclusion: Every update is addressed as soon as possible so that it is evenly distributed.

Use of Logical Operations in Prepositions

Mathematical Logic Operations contains a collection of operations including: Negation, Conjunction, Disjunction, Implication, and Biimplication.

1. Negation (~)

   Negation is a statement that is formed from the original statement, which is "true" if the first statement is "false", and is "false". If the first statement is "true" there is a statement p and another statement called the negation of p.[9]

   The negation of p is denoted by the symbol ~p. The statement (~p) states that the decision is opposite in value to the other decisions (p). The application of the sentence can be written in the form of "Not true..." which is placed into a statement arrangement. Can be placed before the p statement, can also be placed after the p statement. From here we can make some logical statements containing Negation.

   The following is a Problem Model that has been made by Negation :
   p : All reforms in this village must be addressed as soon as possible.
   ~p : It is not true that all updates in this village should be addressed as soon as possible.
   q : Every update is carried out evenly.

2. Conjuction (∧)

   Conjunction is a combination of 2 statements using the word "and". The writing symbol for this operation is denoted (∧). The format for writing conjunctions is that if the existing statement notations are p and q, then it can be written as "p ∧ q". The determination of the truth value of p ∧ q in Conjunction is as follows:

   - If p is true and q is true, then p ∧ q is true.
   - If p is true and q is false or vice versa, then p ∧ q is false.[10]

   So, the statement is true if both are true, but false if one of the two is false. Thefollowing problem model has been made by Conjunction:

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p : All developments in this village must be addressed as soon aspossible.
q : Every development is built equally.
p∧ q : All developments in this village must be addressed as soon as possible and every development is built evenly.

3. Disjunction (∨)

A disjunction is a combination of two statements using the word "or". The writing symbol for this operation is denoted (∨). The format for writing conjunctions is if the statement notation is p or q then it can be written with "p ∨ q". The determination of the truth value of p v q in the disjunction is as follows:

- p ∨ q is True if both are True.
- p ∨ q is False if both are False.

So, a statement evaluates to true if both are true, but false if both are false. The following problem model has been made by Disjunction:

p : All developments in this village must be addressed as soon as possible.
q : Every development is built equally.
p ∨ q : All developments in this village must be addressed as soon as possible or every development should be built evenly.

4. Implication (⇒)

Implication is a conditional statement that is made from a combination of 2 statements using the word "if..". The writing symbol of this logical operation is denoted (⇒). The format for writing conjunctions is if the statement notation is p q then it can be written as "if p then q". The determination of the truth value of p q in the Implication is as follows:

- p⇒q is True if both are True.
- If p is false and q is true, then it is possible that p ⇒q is true.

So, a statement evaluates to true if both are true. However, the statement is still true if p is true and q is true. The following is the problem model that has been made. Implications:

p : All developments in this village must be addressed as soon as possible.
q : Every development is built equally.
q ⇒p : If every development is built evenly then it must be addressed as soon as possible.

5. Biimplication (⇔)

Biimplication is that if p and q are assembled and connected using the conjunction "if and only if" then a new statement is obtained "p if and only if q". The biimplication can be written as “p ⇔ q”. The determination of the truth value of p q in the Biimplication is as follows:

- If both are True, then p ⇔ q is True.
- If both are False, then p ⇔ q is True.

So, a statement evaluates to true if both are true and false. The following problem model has been made Biimplication:

p : All developments in this village must be addressed as soon as possible.
q : Every development is built equally.
p ⇔ q : All development in this village should be addressed as soon as possible if and only if every development is built equally.

1. Truth Table Design

To get a more accurate decision, it would be better if the two statements were arranged in the form of a truth table.

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Table 1. Truth Table

P	**q**	$\sim p$	$\sim q$	**p ∧ q**	**p ∨ q**	**p ⇒ q**	**p ⇔ q**
T	T	F	F	T	T	T	T
T	F	F	T	F	T	F	F
F	T	T	F	F	T	T	T
F	F	T	T	F	F	T	T

Information :
p : Is a statement A
q : Is a statement B
The following is one of the problems in the real world that was discussed in the deliberation :
Case 1:
2 bullets strayed into the room of members of the Supreme Court. Therefore, the MA Building must be installed with bullet-proof glass so that the building is safe.
Premise :
P : 2 bullets targeted the MA members' room.
q : The MA building is installed with bullet-proof glass.
r : Safe building.
Questions in deliberation:
Should we install bullet-proof glass if there are only 2 bullets targeting the MA building?
Statements in informatics logic:
If there are two bullets in the MA Building, then the MA Building is installed with bulletproof glass and the building is safe.
Solution 1: if p then q and r
Solution2 : p ⇒ (q ^ r)
Truth table:
Table 2 Consensus Truth Table

P	**Q**	**r**	**p ∧ q**	**p => (q ^ r)**
T	T	T	T	T
T	T	F	F	F
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	F	T
F	F	T	F	T
F	F	F	F	T

True = 5, False = 3
Conclusion :

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Based on the data in the truth table that has been obtained, the final result of the statement is a tautology (true), because the number of "true" values is greater than the "false" values. Then the statement in the deliberation can be taken/implemented.

Case 2 :

The government will give a maximum prize of IDR 300,000,000 if someone reports a corruption case. And this is a new policy that will be implemented in the future.

Premise :

p : The government gives a maximum prize of IDR 300,000,000
q : Someone reported a corruption case.
r : Is a new policy.

Questions in deliberation:

Is it necessary to implement a new policy, namely giving a maximum gift of Rp. 300,000,000 by the government if someone reports a corruption case?

Statements in Informatics Logic:

The government will give a maximum reward of IDR 300,000,000 if and only if someone reports a corruption case and it is a new policy.

Solution 1: (p if and only if q) and r

Solution 2: (p ⇔ q) ^ r

Truth table:

Table 3 Truth Table of Deliberation

P	**q**	**R**	**p ⇔ q**	**(p ⇔ q) ^ r**
T	T	T	T	T
T	T	F	T	F
T	F	T	F	F
T	F	F	F	F
F	T	T	F	F
F	T	F	F	F
F	F	T	T	T
F	F	F	T	T

True : 2, False : 6

Conclusion :

Based on the final result data in the truth table, we can conclude that it is a contradiction (false), because the value of "false" is greater than the value of "true". So the statement at the deliberation is not taken/cancelled.

CONCLUSION

From the results and discussion of the research, it can be concluded that according towith the paper title "The Use of Mathematical Logic in Determining Deliberation Decisions" the author concludes that by usingMath logic as decision making in deliberation can be done. As forThe advantages and disadvantages of this experiment are as follows.

Excess :

1. Accurate in determining whether or not a problem is true.
2. Easy to use to determine various problems.

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3. Quick in determining the problem so that it saves time.

Weakness :

1. Do not know the effect of the decisions that have been taken.
2. Quick in determining the problem when there are only a few statements that exist

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